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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of
Milk-Handling Machinery

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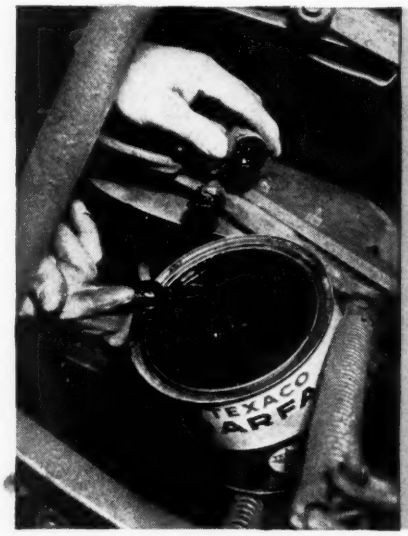

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Lubrication of Milk-Handling Machinery

THE dairy industry is productive of some very enlightening statistics—it is also productive of an almost unbelievable quantity of milk—some 45 million quarts daily. So, 25 million cows serve 130 million people, for everyone consumes milk in some form or other. As the development of plastics progresses, perhaps we'll wear milk; in fact, it is already quite widely used for hats. Our esteemed contemporary, "Shell Progress,*" has told the story of milk in terms of some amazing statistics.

The mechanics of milk handling, of course, requires machinery involving a variety of pumps, conveyors, centrifugual separators, speed reduction devices, electric motors, homogenizers, can washers and refrigerating equipment.

Lubrication of all this machinery must be given most careful consideration. We must select only lubricants of the highest quality, of proved adaptability for the service involved. Then we must apply them with the utmost care, realizing that drip or leakage may contaminate a considerable volume of milk.

So, the modern dairyman does not simply go down to the corner service station and pick up ten gallons of oil or five pounds of grease. He studies the instructions which the builders of his motors, speed-reducers, pumps, etc., have prepared. Usually, these are complete with information as to bearing design, type of gears and nature of the housings. But still not complete enough with respect to the characteristics of lubricants. So, he consults his lubricating engineer. In this way he can round out his information regarding the types of lubricants which would be best suited for the particular operating conditions.

Dairy plant temperatures may vary widely, according to the type of operation involved. Quite a lubricating problem may be involved on cold room conveyors, where temperatures considerably below normal prevail. In addition, in many parts of the dairy farm or plant considerable moisture will prevail, due to the necessity for constant hosing and cleaning of the machinery and the accessory piping and fittings. Under moisture conditions anywhere, care must be observed both in the selection of lubricants and their application. Quality lubricants are always most dependable.

POWER DRIVES

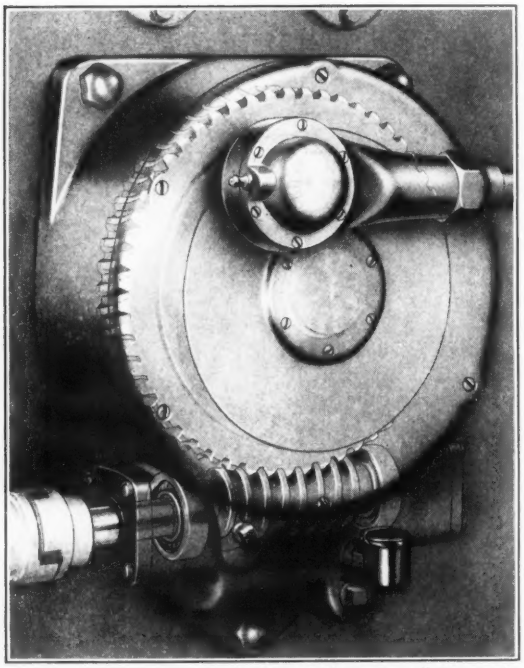
Modern dairy machinery is powered by the electric motor. The application will depend upon the speed at which the driven machinery is to operate. Where high speed units such as the centrifuge or centrifugal pump are involved, the motor is usually direct-connected to the driven unit. Conveyors and the vacuum pumps on milking machines, on the other hand run at slower speeds. Accordingly, they are driven through belt connections, geared motors or some other type of speed reduction mechanism.

Lubrication of the motor and speed reduction mechanism will obviously depend upon the type of design. Some mechanisms require individual lubrication, i.e., the electric motor. Others, such as the enclosed speed reducer or geared motor, rely upon the one lubricant to serve both the gears and bearings.

*Dairy Products, "*Shell Progress,*" November, 1941.

The Geared Motor

There are several types of geared motors available to the dairyman. All are adaptable to service where considerable reductions in speed are necessary.



Courtesy of Cherry-Burrell Corporation

Fig. 1—Phantom view of the gear drive of a Cherry-Burrell type CC spray pasteurizer.

The geared motor is usually so completely housed that leakage of lubricant is virtually eliminated. It is a typical self-lubricating device, equipped with conventional bearings of the anti-friction type which can be oil or grease lubricated. Grease is usually preferred, using a highly refined specially compounded grease of medium consistency.

The reduction gear set, however, is designed for oil lubrication, the oil being contained in a bath at a sufficient level to insure proper dipping of the lower gear teeth. As a general rule it is advisable to keep the oil bath at from one-third to one-half full, so that the bottom gears will be about half submerged. For such service an oil of from 500 to 900 seconds Saybolt viscosity at 100 degrees Fahr. (SAE 30 or 40) will be suitable according to the operating temperatures, the extent to which heat may be carried to the gear case from the motor, the location and the amount of air cooling which may prevail.

Independent Reduction Gear Sets

Where reduction gears are located in an independent housing or built as a separate unit from their driving motor, the method of lubrication will depend largely upon the design of the gears and the manner of housing. Normally this latter provides for complete enclosure so that possible leakage of lubricant is reduced; also, the possibility of contamination of the milk.

A variety of gear designs can be adapted to dairy service. In general, the chief requirement is considerable reduction in speed. The bevel or worm gear drive is particularly applicable. The selection of the lubricant for such a drive must be based upon the type of gear casing. In other words, an oil tight case will permit bath lubrication and the use of a lubricant of just sufficient viscosity to preclude wearing of the teeth.

Worm Gear Requirements

Worm gear operation requires a lubricant of comparatively high viscosity and sufficient adhesiveness to resist being wiped off the teeth when subjected to their combined sliding and rolling action. In many installations the same lubricant must lubricate not only the gears but also the worm shaft thrust bearings. Inasmuch as the lubricating requirements will differ considerably, in such cases it will be necessary to compromise and use a lubricant as suitable for both as possible. An SAE 140 gear lubricant or a compounded steam cylinder oil will generally be suitable for dairy service where the small enclosed reduction gear set prevails.

Bevel Gear Drives

Some of the machinery, however, may be equipped with bevel gear drives. If these latter are enclosed in a suitable housing or provided with a base reservoir, it will enable the use of more fluid lubricants than are generally used on conventional worm reduction gear sets. Oftentimes a straight mineral oil of about 750 seconds Saybolt viscosity at 100 degrees Fahr. (SAE 30) will suffice. Where the prevailing pressures and slow speeds require a heavier lubricant, capable of adhering tenaciously to gear and pinion teeth, an oil having a viscosity of approximately 100 to 150 seconds Saybolt at 210 degrees Fahr. (SAE 140) may be advisable.

Exposed Gearing

When gear drives are not enclosed in an oil-tight casing, bath lubrication is usually out of the question. Then it becomes necessary to apply the lubricant by hand. In such instances the lubricant must be of fairly high consistency since it must maintain a suitable film on the gear teeth for a considerable period of time.

Dirt, dust, water and perhaps animal acids must be considered when lubricating reduction

gears of this type. Frequent attention should be given, therefore, to cleaning the entire mechanism, especially if located in the basement or beneath the milking floor, otherwise excessive wear or corrosion may develop due to impairment of the lubricating film.

Anti-Friction Bearings

The extent to which the electric motor and the conveyor are used in some form or other in the modern dairy warrants thorough discussion of the improvements in bearing design which have taken place in recent years. Particular thought has been given to ball and roller bearings by many of the manufacturers in the interest of protecting the moving elements from contaminating foreign matter, and reducing power consumption.

The average conveyor is deceiving as to the importance of its bearings. It is able to function under a wide variety of intensive operating conditions, and frequently dust, dirt or other non-lubricating material do not seem to affect its ability to operate; on the other hand, power consumption may be markedly increased. Particular effort has been devoted to devising means to prevent entry of non-lubricating matter or acid liquors.

Contrast of Operating Principles

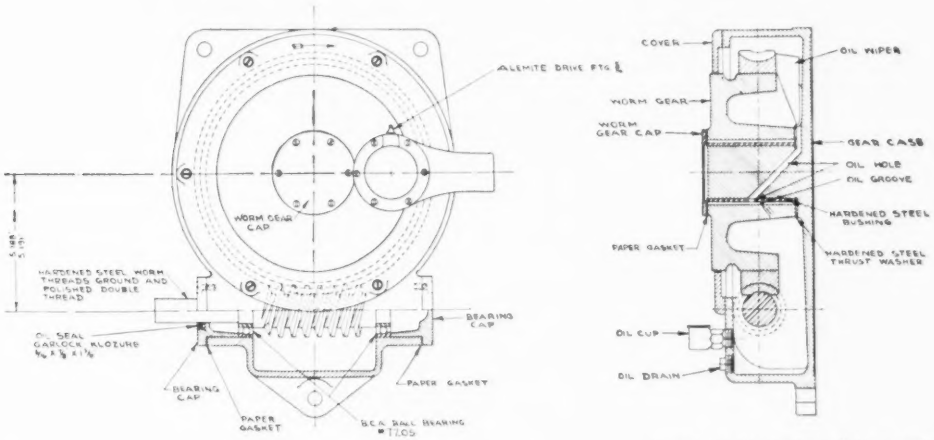
The ball or roller bearing can be designed to be more independent of lubrication than the plain or sleeve type bearing. It only requires careful attention to the type of seal employed. In fact, as one of the primary functions of the lubricant is to protect the highly polished surfaces of the rolling elements against possible corrosion, the value of the seal in preventing entry of corrosive materials should not be overlooked. It materially reduces the duty imposed upon the lubricant.

In the plain or sleeve type bearing, on the other hand, regardless of the means of lubrication or the lubricant used, the ultimate speed that can be developed and the load that can be carried will depend upon how effectively the lubricating system maintains an adequate film of oil in circulation through the clearance spaces to remove frictional heat and prevent metal-to-metal contact of the sliding surfaces.

How Lubrication is Related to Wear

As the ball or roller bearing normally involves a minimum of friction, it is an asset wherever the occurrence of wear may be a detriment to productive efficiency and accuracy. Rolling motion will obviously not be apt to cause as much wear as will sliding motion.

On the other hand, rolling motion in an anti-friction bearing must be maintained as perfectly as possible. Should any one or more of the balls or rollers cease to roll and begin to slide, this will react to the detriment of the contact surfaces of itself as well as the raceways. To an extent this would be similar to the operation of a plain bearing from the viewpoint of the type of friction developed, but with comparatively negligible means of counteracting this, for the prevailing lubricant would in all probability not be able to maintain an adequate load-carrying film or remove such frictional heat as would probably be developed.



Courtesy of Cherry-Burrell Corporation

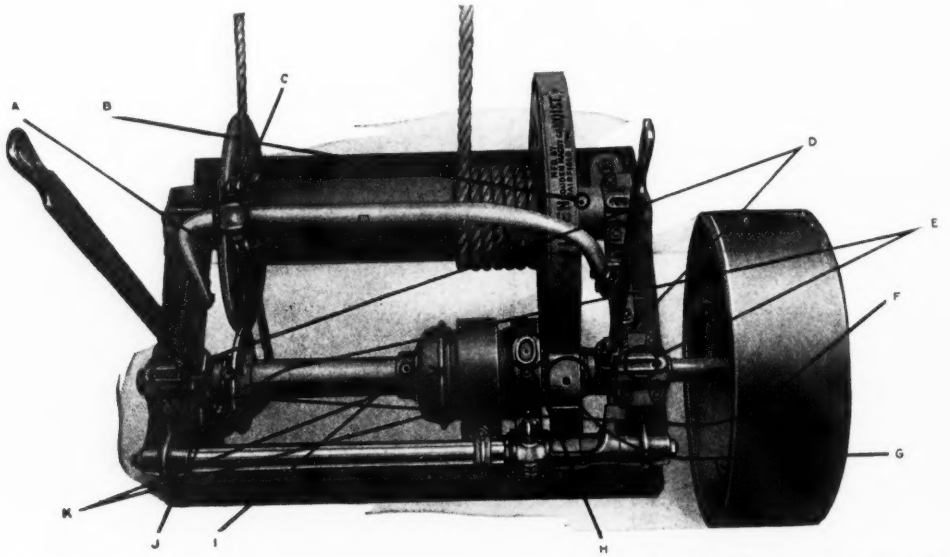
Fig. 2—Constructional details of the gear drive shown in Fig. 1. Note features pertinent to lubrication such as the oil wiper, oil hole and groove at the gear shaft bearing, the Garlock oil seal on the worm shaft, the worm shaft ball bearings and the oil cup and drain.

Constructional Features

The modern anti-friction bearing will comprise a set of perfectly spherical balls or an arrangement of solid or flexible rollers.

The essential difference between any par-

ticular types of ball bearings will be in the design of the housing. In the roller bearing, however, the design of the roller will be the chief characteristic. In general, this will be either solid or flexible. The latter is always cylindrical in shape, the distance between the inner and outer raceways being uniform throughout the length of the roller. Solid rollers, on the other hand, may be either cylindrical or tapered according to the type or design.



Courtesy of The Louden Machinery Co.

Fig. 3—Lubrication chart for a Louden power hoist which is applicable to dairy farm service. This unit is designed for oil lubrication, the various arrows indicating the oil holes or oil cups for this purpose. The frequency of oiling will depend upon the service.

Manner of Housing

Ball or roller bearings as applied to dairy machinery are housed in much the same manner, irrespective of the nature of the rolling elements, i.e., in suitable containers comprising raceways or cages. In a typical design the inner race will fit on the shaft or journal, the outer being held by the frame or other rigid part of the bearing.

Between these so-called raceways are located the balls or rollers. These are kept in their proper position with respect to the races and to each other by the separator, cage or retainer. Rotation of the shaft sets up a rotary motion between the rolling elements and the respective inner and outer surfaces of the raceways.

As a general rule, when oil is used, the housing should be filled to a level sufficient to submerge approximately half of the lower-most ball. With grease, however, somewhat more lubricant is used, the housing being from one-quarter to one-half full. The lubricant in a ball or roller bearing does not promote cooling to any great extent. Therefore, volume, if excessive, may become a detriment due to churning and internal friction within the lubricant itself.

Grease as a Lubricant

Grease lubrication prevails in the dairy. Greases furnish better seals against the entry of dust, dirt, moisture, or animal acids, thereby serving to protect the polished surfaces of the bearing elements more effectually. Grease can also be more easily retained in a non-oil-tight housing; on the other hand, dirt or grit that finds its way into a grease-lubricated bearing has no means of settling out, but is always held in suspension, being carried back repeatedly into contact with the bearing elements.

A grease for ball or roller bearing lubrication should:

1. Show no tendency to separate oil in storage or when inactive within a bearing. Nor should this occur under moderate heating.
2. Show no tendency toward hardening or decomposition.
3. Be free of constituents which might lead to corrosion, pitting or rusting of bearing elements.
4. Be free of components which might tend to cause the lubricating film to become sticky or the grease itself to gum.

As a general rule, greases of average consistency will meet normal operating conditions

in dairy service where the lubricant must readily cover the entire surfaces of the balls or rollers and not tend to channel in the housings or raceways, as might occur with heavier products which would be less capable of being thoroughly distributed.

Flushing and Cleaning of Bearings

To insure the maximum protection with any anti-friction bearing lubricant it is absolutely essential to keep the lubricating system as free from foreign matter as is consistently possible, according to the operating conditions and bearing construction.

There is always possibility of entrance of impurities especially where the bearing is not properly sealed. When this occurs the continued churning of abrasive foreign matter with oil or grease, in intimate contact with highly polished balls, rollers and raceways, may ultimately ruin the bearing.

Since it is not always possible to seal effectually or to depend upon the seal being in good order at all times, lubricating systems should be flushed and cleaned at periodic intervals. The frequency will, of course, depend upon the design of the bearing, the type of seal, the lubricant used and the extent of exposure to dust, dirt, moisture or animal acids.

Chain Drives

Chain drives form an essential means of power transmission, both in the operation of certain types of dairy equipment as well as in the bottling plant. The usual construction of the link mechanisms and the comparatively large number of moving parts require continual protection by means of lubrication to prevent abnormal wear. Lubrication, furthermore, facilitates free bending or articulation.

The silent chain and the roller type construction are well suited to dairy equipment. Lubrication requirements of such chains can be best realized by study of the construction of the link mechanisms. In the silent chain this will involve a pin and bushing arrangement, or a form of rocker joint connection.

The silent chain includes all such driving mechanisms as are built up of parallel series of links of such a contour as to enable them to engage with teeth on the sprocket wheels so that power transmission is positive. These links are fastened to each other and to the adjoining links by pins and bushings, or seat and rocker pins. This type of construction gives exceptional bending ability to the entire chain, with very little wear and noise, provided lubrication has been properly carried out. Little or none of the lubricant will normally be thrown off by centrifugal force, even under higher speeds. Clean operation is, therefore, also an advantage, especially on over-head installations where the chains and sprockets may be exposed.

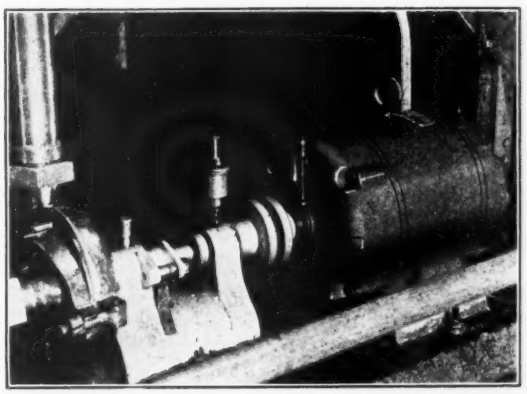
The modern roller chain is designed and constructed to a high degree of accuracy, bearing surfaces being machined to a smooth finish in order to enable effective lubrication, and insure against abnormal wear, particularly under high operating speeds.

Factors Governing Chain Lubrication

Dependable lubrication of driving or conveyor chains requires careful study of operating conditions. Only by combining a knowledge of such factors as speed, load, clearances and extent of bending can proper lubrication be attained.

On slow moving types of chains the lubricant can be brushed uniformly over the wearing surfaces while they are operating slowly. Higher speed mechanisms may be bath lubricated, depending upon whether they are operated exposed or in an oil-tight casing. The speed of operation is oftentimes regarded as a guide as to whether a casing should be used. Naturally, a chain which operates in a dust-proof, oil-tight casing, which is equipped with some form of automatic lubrication, will require the least attention and operate most efficiently.

Splash lubrication can be developed by means of a disc attached to one side of the main shaft. As the wheel rotates the disc dips into the oil in the base and throws it to the top of the casing, which is built in the shape of a wedge. Thus there is a continuous and uniform dripping of oil upon the chain. In casings of this type, the oil level is below the chain, the disc dipping in it to a depth of somewhat less than one inch. Where bath lubrication prevails, however, the oil level should be somewhat above the lowest part of the chain. Casings which are used on high speed chains,



Courtesy of Century Electric Company

Fig. 4—A Century splash-proof motor application to a milk handling pump. Note lubrication attachments for both motor and pump bearings.

in turn, are often equipped with an oil pump, the oil being sprayed continually on the chain.

Where such chains are lubricated by the manufacturers before they leave the factory, a soaking bath is used, the chains being immersed for a sufficient length of time to allow penetration to all interior parts. Such treatment is regarded as insuring efficient lubrication for the first few weeks of normal operation, if dust conditions are not excessive. Subsequent soaking of the chain in the lubricant at periodic intervals is advisable whereever possible. When it is impracticable to remove a chain for such treatment, the bearing or driving surfaces should be brushed with a light, uniform coating of lubricant about once a week, or more frequently if necessary. If this is done during slow operation, satisfactory penetration to all the joints will occur through the combined effects of bending and capillary action.

By reason of the small clearances which prevail, it is generally advisable to use a relatively fluid straight mineral lubricant. When chains are encased, if they are to be bath lubricated, an engine oil having a viscosity of about 500 seconds Saybolt at 100 degrees Fahr. will be suitable. Where exposed, or encased but not submerged in oil, a heavier product, such as a mineral cylinder oil or a medium gear lubricant (SAE 140) should be used.

Courtesy of Walter Maguire Company, Inc.

Fig. 5—Showing a Maguire conveyor and motor-driven speed reduction gear set.

CIRCULATION AND PUMPING

Pumps are used for two purposes in the modern dairy, viz.: for creating a partial vacuum, in connection with mechanical milking, and handling the milk itself. In fact, after milk has been picked up and collected for shipment to the pasteurizing or distributing center it is handled almost entirely by pumping. The various stages of handling include collection by the sanitary pumps from the tank trucks; thence to the separators, coolers, pasteurizers and homogenizers, and finally to the bottling and capping machinery. From here to the route trucks, the bottles and cases are handled by conveyors.

The rotary (blade-type) pump is used for vacuum purposes; the small high-speed rotary or gear pump being used in the modern dairy or milk distributing plant. Pumps of this type involve no valves, springs or other small parts to wear out or become inoperative. Furthermore, in the gear pump there are no internal parts to be lubricated; only the bearings of the splash-proof driving motor and the pump shafts.

Pump Characteristics

Pumps with two rotating elements are commonly known as rotary devices, whether these elements are gears, screws, pistons, impellers, or cycloids. Essentially the principle is that of the geared pump, the matter of teeth or lobes being the criterion. With certain types such as the cycloidal for example, while the discharge is continuous it is not uniform, therefore air chambers are usually required on both the suction and discharge sides. These chambers act on the principle of the accumulator or fly wheel, absorbing any excess of product at the time of maximum flow to discharge it at the time of minimum flow thus insuring uniform velocity.

The pulso-pump as applied to the milking machine has only one rotor, this being built

with four blades which are oil-sealed to create four vacuum strokes at each revolution.

Lubrication

Pumps which are equipped with two rotating elements require lubrication of the bearings only; no internal lubrication is necessary as this is maintained by the fluid which is being pumped. The bearings may vary in design and involve specific problems according to the operating conditions and the amount of moisture present. As a result, they require serious consideration and cannot be passed over as mere instances of ring oilers, ball bearings, etc., or plain babbitted bearings served by oil or grease cups.

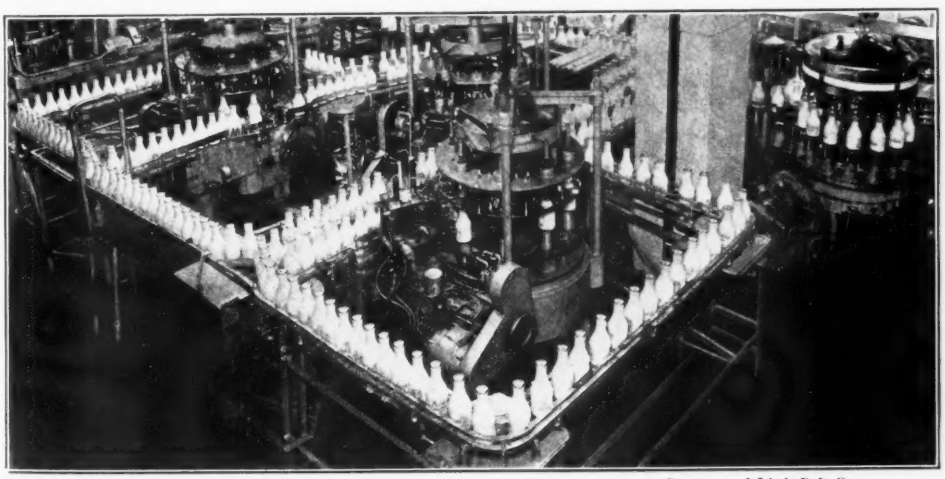
The ring oiler is comparatively simple, cleanly and capable of automatic lubrication, with but very little attention. It comprises a bearing housing which is built with a reservoir and a slot of sufficient width and depth to permit one or more rings suspended from the shaft to revolve therein. As a result, with the revolution of the shaft, these rings being subjected to rotation, will carry a certain amount of oil to the top of the shaft from whence it is able to flow into the bearing oil grooves and clearance space to be ultimately distributed to the entire wearing surface. After the oil has passed through the bearing, it flows out to the end or ends of the shaft through a suitable return chamber which is part of the bearing housing, back to the oil reservoir below.

Ring oiling enables the bearings to be flooded with a considerable excess of oil over the amount that would theoretically be necessary to furnish the requisite oil film. By flooding the bearing with oil, the latter serves not only as a lubricant, but also as a cooling medium to carry away part of the frictional heat developed, thereby reducing the temperature of operation.

Ball or roller bearings are also used on certain types of milk-circulating pumps. As such bearings supplant sliding motion with rolling motion, friction is theoretically reduced where they are properly lubricated. Wherever possible, the housings should be oil-tight; then the body of the lubricant can be reduced, also any internal friction that develops during operation.

Where leakage may develop, a grade of grease should be used which will have just enough body to cause it to remain in the bearing housing. Lubricating attachments may or may not be used on such bearings; irrespective of their use, however, it is necessary to charge or fill the housing and raceways periodically with the proper grade of lubricant, through a suitable orifice or fitting which can be effectively sealed or plugged during subsequent operation to prevent the lubricant from flowing out. In general, one charge of oil to a roller or ball bearing equipped with an oil-tight housing should last for a period of several months. Where grease is required, however, it should be renewed about once a month, according to the extent of seal which is maintained.

The pulso-pump being strictly a vacuum pump and not used for handling milk, requires lubrication of the blades and cylinder walls, as well as the rotor bearings. Accordingly, the rotor and blades run in a bath of oil, creating an oil spray which maintains lubrication. Oil is supplied from an inverted sight feed bottle which maintains the proper oil level in the pump itself.

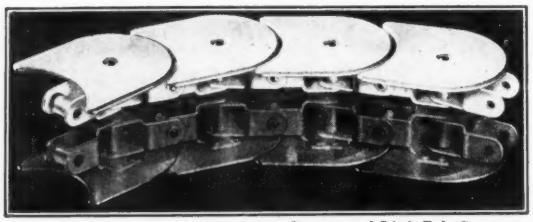


Courtesy of Link-Belt Company

Fig. 6—A Link-Belt Universal Carrier chain conveyor for handling milk bottles.

AIR POWER AND VACUUM

In the circulating and grading of milk prior to bottling, certain of the tanks may be filled by vacuum; others in turn may be discharged by imposing air pressure on the contents. This



Courtesy of Link-Belt Company

Fig. 7—A section of the Link-Belt Universal Carrier chain showing details of the mechanism.

presents the problems of vacuum pump and air compressor lubrication. Both must be approached from the viewpoints of careful selection and application of cylinder oils in order to prevent any possibility of oil contamination of the milk.

Handling of milk by air pressure is unique with regard to the extent to which the air must be filtered. Charcoal, water or felt, either alone or in combination are used for this purpose. In addition to removing solid contaminating materials, charcoal or felt will also remove effectually any traces of air compressor cylinder oil which may have been taken up by the air. This is not to infer, however, that compressor lubrication can be slighted; for excessive oil feeds, or use of an unsuitable oil might lead to overloading of the filters to reduce their effectiveness, or to faulty operation of piston rings which might reduce compressor efficiency. So a word as to compressor lubrication is advisable.

High Quality Is Necessary

The nature of the operating conditions to which the oil will be subjected is unique. There may be a considerable temperature range; furthermore, as this may approach quite a high maximum there may be considerable possibility of breakdown of unsuitable oils with accumulation of more or less carbon residue. Enclosed mechanisms or interior surfaces are involved which do not permit of easy inspection. These may be rotating or reciprocating, according to design, but all involve more or less sliding friction.

Viscosity of the Oil

Viscosity or body is related to piston ring or vane seal, according to the type of machine; consequently, it affects the efficiency. If the oil is too light in body or of too low a viscosity it may not furnish the required seal at the peak temperatures of compression. Then increased oil consumption or air leakage may result.

The usual viscosity range for reciprocating compressors in dairy service will be from 200 to 300 seconds Saybolt Universal at 100 degrees Fahr. For rotary (blade or vane type) units, somewhat heavier oils are preferred to maintain the seals, i.e., from 50 to 125 seconds at 210 degrees Fahr.

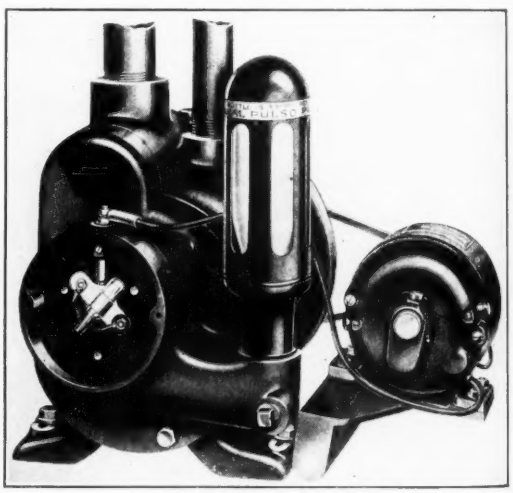
The rotary type of machine normally requires a heavier oil than the reciprocating unit (for the same compression range) due to the scraping action of the blades against the cylinder wall.

Carbon

Carbon deposits may result from exposure of an oil to heat and air. This involves a chemical change. If this heat is sufficiently intense, it causes abnormal vaporization of the more volatile constituents to result in accumulation of non-lubricating (oxidized) matter which may be of tarry or gummy nature. Continued exposure of the latter to heat causes coking or baking in piston ring grooves, on valves or elsewhere in the compressor. Accordingly, the cleaner an oil will vaporize the lower will be the amount of objectionable residues.

Application of Compressor Oils

The rate of oil delivery has a direct influence

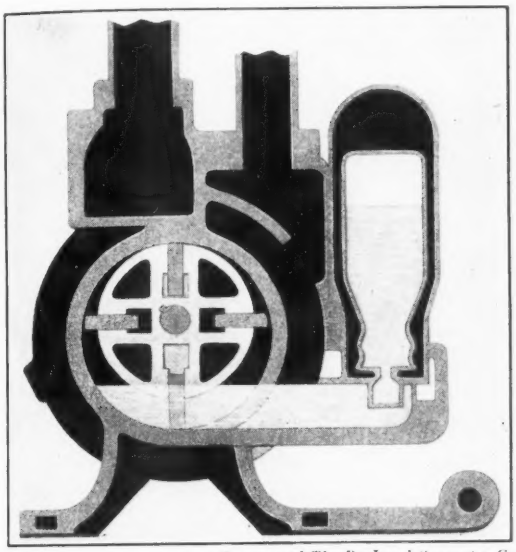


Courtesy of The De Laval Separator Co.

Fig. 8—Exterior view of the Pulso-Pump which is used with the De Laval magnetic milker. The rotor has four oil-sealed blades which run in an oil bath to create a spray which lubricates all the moving parts. Four vacuum strokes developed at each revolution.

upon the possible amount of carbonaceous matter which may be developed during operation. If an excess of oil is continually delivered to the cylinders, some of it must be carried over with the air to collect in the intercooler or in

pockets elsewhere in the system. Conversely, too little oil may result in impaired lubrication. So, the means by which compressor oils are applied is of considerable importance in the ultimate development of effective lubrication.



Courtesy of The De Laval Separator Co.

Fig. 9—Cutaway view of the Pulso-Pump as shown in Fig. 8 showing how the oil is fed into the pump by means of an inverted bottle, which also automatically maintains the proper oil level.

Point of Delivery

On larger units the oil is usually delivered by a mechanical force feed oiler. On smaller units splash may be used. Where controlled lubrication is possible, on account of the small amount of oil involved, and the fact that a filtered oil is more readily atomized, the lubricator is generally located fairly near the intake or cylinders, as atomization is effected in a relatively short distance.

In this way the possibility of over-feeding oil to any particular part is reduced; oil flow stops and starts with the compressor, and the desired lubricating and sealing film is more nearly assured. Furthermore, force feed lubricators are not affected by variations in air pressure, and they will feed the oil at the desired rate in accordance with their adjustment, the speed of the compressor, and the viscosity of the oil.

REFRIGERATION IN THE DAIRY

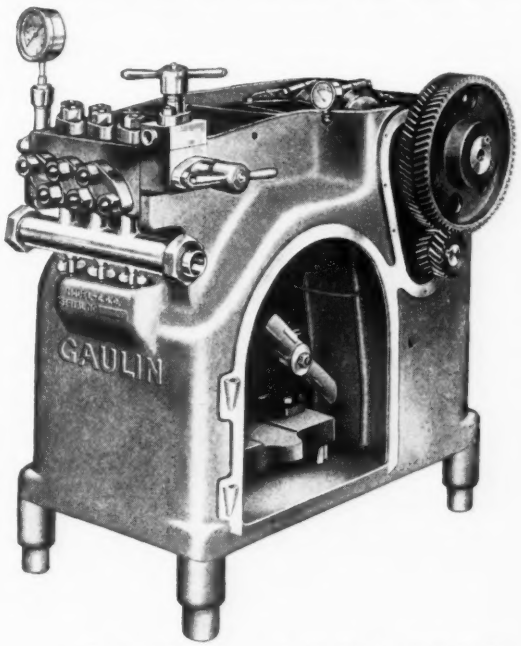
During the course of handling of milk from the dairy through the bottling plant, and even during distribution, temperature has an important relationship to the bacteria count. The most advisable temperature range is from 35 to 40 degrees Fahr. Any material rise will cause a marked increase in the bacteria count. Chillers are required for temperature control as milk passes through the bottling plant; flake ice is used in cold room storage and also for packing cases in order to keep bottled milk as nearly as possible at the required temperature while in transportation incident to delivery. So the dairy industry is actively interested in refrigeration and the effective lubrication of refrigerating compressors.

In this connection we must consider the action and effects of the oil upon the actual wearing surfaces as well as upon parts not requiring lubrication.

In other words, oil congealed in any part of a cooling system will tend to reduce refrigerating efficiency due to its becoming so sluggish under the low temperatures involved as to form an interior lining in the expansion coils and materially affect heat transfer.

An oil for refrigerating machinery lubrication must, therefore, remain fluid at the lowest temperatures to which it may be subjected during operation. These temperatures will be encountered in the expansion or cooling side of the system.

Consideration must also be given to water. It is essential that the oil at all times be practically free from water, for water will freeze if carried over to the cooling coils or expansion valves in which case it would probably remain in the system and result in a certain decrease in evaporative efficiency.

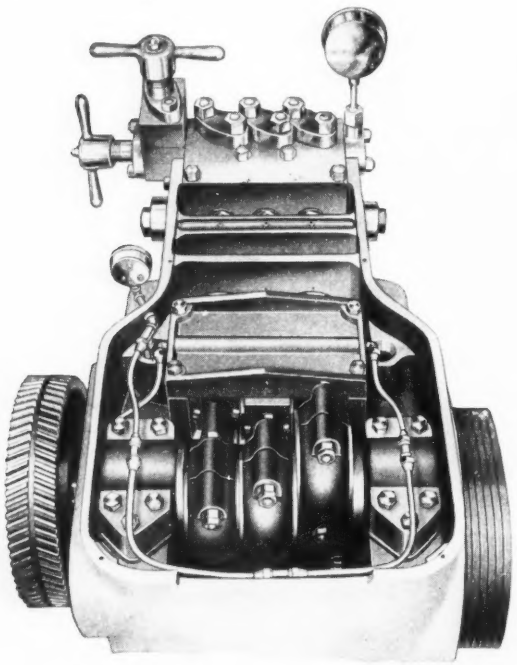


Courtesy of The Manton-Gaulin Manufacturing Co., Inc.

Fig. 10—Showing accessibility of the mechanism gear side of a Gaulin two-stage homogenizer. Lubrication of this mechanism has been given very careful thought. The oil level in the gear case is accurately maintained and by control of air circulation, entry of water is prevented; consequently condensation of moisture in the oil sump is prevented.

Types of Lubricants

For normal ammonia compressor service a straight mineral filtered oil having a viscosity around 150 seconds Saybolt at 100 degrees Fahr., will be necessary where the temperature



Courtesy of The Manton-Gaulin Manufacturing Co., Inc.

Fig. 11—Top view of the homogenizing mechanism of a Gaulin two-stage homogenizer. Note the oil tubes which carry oil under pressure to all bearings and crossheads. The eccentric shaft is drilled for circulation of oil to each eccentric strap.

in the refrigerating coil is below 5 degrees Fahr.

Above this temperature an oil of somewhat higher viscosity, i.e., 200 to 300 seconds Saybolt usually is advisable.

The Importance of Viscosity

Viscosity is a factor where enclosed crankcase, high speed machines are used in connection with evaporating systems which may allow liquid refrigerant to return to the compressor. The one oil often lubricates the entire machine. As a result, it must be capable of serving both the cylinders and the bearings. It should not emulsify to any great extent, for this might result in stoppage of the lubricating system or impairment of refrigeration should oil work past the piston rings and over to the cooling side.

The Pour Test

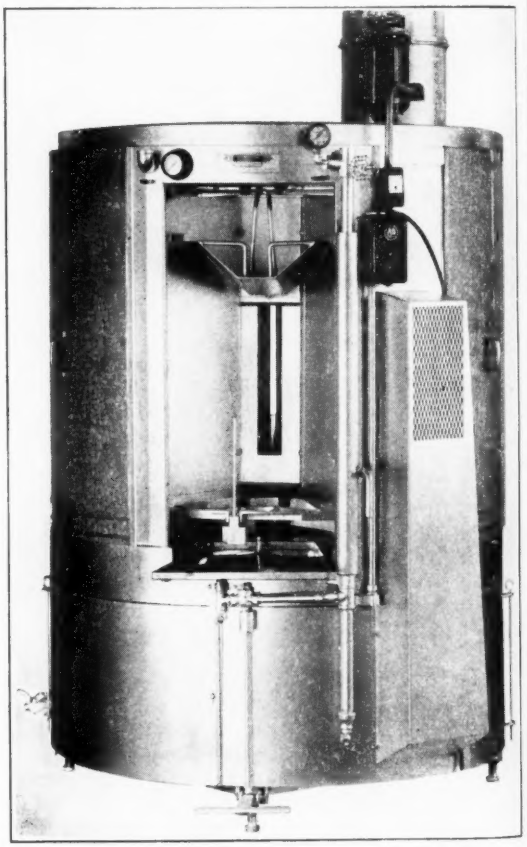
The pour point of a petroleum oil is the lowest temperature at which it will pour or flow when chilled without disturbance under definite prescribed conditions. This test is of prime importance in the consideration of a refrigerator oil, as it is usually associated with the wax content and viscosity of the oil. In other words, as these increase they will cause the pour test temperature to increase.

Lubricating Systems

Splash or pressure lubrication will be involved according to the type of compressor. The latter is suitable for the lubrication of both vertical and horizontal machines. The former, however, is more adapted to the vertical compressor.

In a splash-oiled system oil is distributed at each revolution of the crank, the level being maintained just high enough to permit the crank to dip and splash the necessary amount of oil to the cylinder walls.

Careful attention is necessary, especially



Courtesy of Damrow Brothers Company

Fig. 12—Open view of a Damrow rotary can washer showing steaming attachment.

when recharging the case with oil, to see that the level is not raised too high. The result would be churning by the crank, to cause such violent agitation in the main body of oil as to oftentimes retard effective precipitation of any

solid impurities that may have gained entry. When piston rings are not sufficiently tight, if the crankcase contains too much oil or agitation is too violent, the excess which naturally will reach the cylinder walls will tend to work past the rings. This is not only wasteful, but also a detriment, for oil in the refrigerating lines will impose an added load on the oil separator. Furthermore, if by chance the oil is not of sufficiently low pour test there will be possibility of its congealment within the system, with reduction in the amount of refrigeration developed.

Pressure Lubrication

Where larger types of vertical or horizontal machines are involved, pressure lubrication is used with marked success. It assures of accurate control of the amount of oil delivered to cylinder walls and compressor bearings. It is also possible to filter or purify the oil where there is provision for circulation.

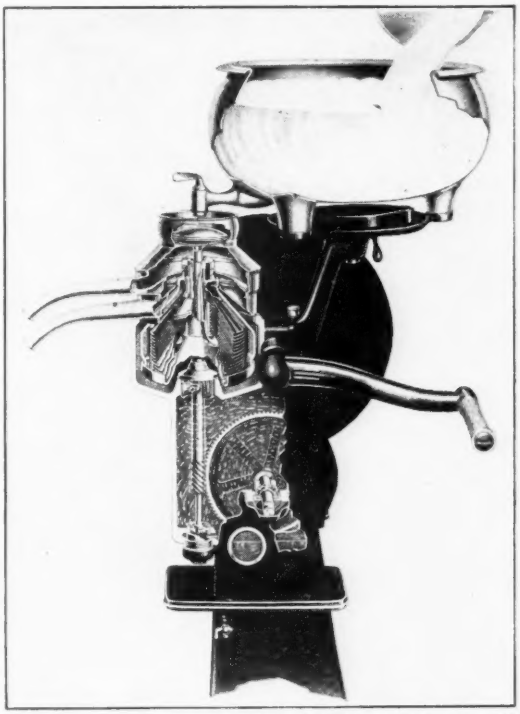
Mechanical Lubrication

External lubricators of this type are extensively used where cylinders only are to be pressure oiled. Excellent economy will be attained by regulating such lubricators so that just enough oil is delivered to maintain lubrication with the least amount of excess.

The Oil Separator

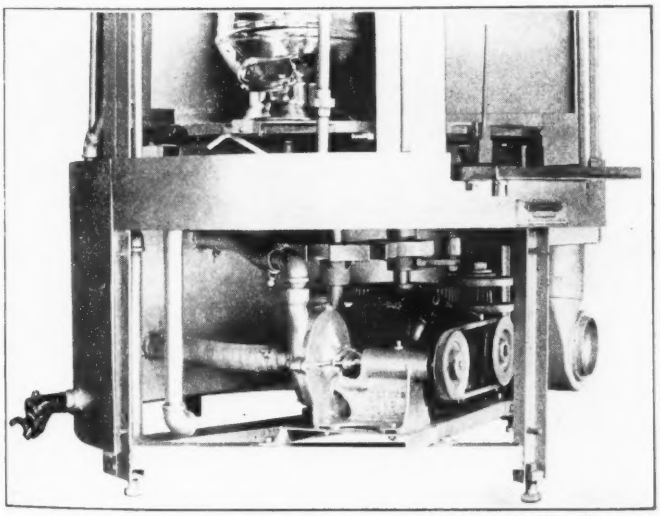
This unit serves to remove any particles of oil from the refrigerant while it is in gaseous form after it has left the compressor. The larger the oil particles, the more effective will be the separator.

A separator should be placed between the discharge of the compressor and the point of entry of the gas into condenser. In certain machines, a drain valve also may be installed below the condenser to enable removal of any oil that may have passed the separator.



Courtesy of The De Laval Separator Co.

Fig. 14—Cutaway view of a De Laval farm type cream separator showing oil being circulated in the gear housing by the action of the gears. The oil level and condition of the oil can be observed in the window just below the worm wheel shaft.



Courtesy of Damrow Brothers Company

Fig. 13—View of the drive mechanism of the rotary can washer shown in Fig. 12. Ball bearings, controlled lubrication and enclosed working parts feature the design of this machine.

Maximum separation is attained by locating the separator as close to the condenser and as far away from the compressor as possible. It should always be of sufficient size to allow of ample reduction in the velocity of the gas in order to permit of effective separation. A smaller separator located some distance from the compressor may often prove more effective than a large separator located nearby.

Care in Handling Lubricating Oil

Any petroleum oil which has been dehydrated will tend to re-absorb a certain amount of moisture when exposed to the air for any length of time. This will result in reduction of the dielectric strength, dependent upon the relative humidity of the air, the temperature range and the length of time it has been so

exposed. The oil should therefore be carefully stored and the container opened only when it is necessary to use the oil; subsequently, if any oil remains unused the container should be sealed as tightly as possible using a special air-tight replaceable top or sealing gasket.

THE SEPARATOR OR CLARIFIER

The cream separator and milk clarifier are important machines in the dairy industry. The separator is used on the farm and in the milk plant for separation of the cream or butter-fat content; the clarifier serves to remove impurities from the milk.

In order to develop the required amount of centrifugal force to bring about the desired results, the separator or clarifier bowl must be rotated at high speed, i.e., around 6,000 turns per minute. This is attained through a relatively high speed-increase worm and gear unit. Power is applied to the gear by hand or by an electric motor, according to the size and type of the centrifuge. The motor, in turn, may be direct or belt-connected. The gear-driven worm which is fixed to the lower end of the spindle on which the separator bowl is mounted, turns the latter at the desired speed.

Milk is delivered to the bowl from above or below according to the size and capacity of the machine. In the farm or dairy cream separator the milk is generally fed in at the top; this type of machine, therefore, is not strictly air-tight. The plant or factory separator, or the milk clarifier which is used for removing sediment, however, can be built to include the air-tight feature, by arranging to deliver the milk from below the bowl via the spindle which is made hollow for this purpose.

The working elements of the separator or clarifier are built to precision dimensions and mounted on ball bearings. The housing is totally enclosed; likewise, the motor is of the splash-proof type, all in the interests of protected lubrication. Fig. 14 shows the action of the oil spray in a farm centrifuge and how oil reaches all the moving parts.

Normally lubrication is continuous and effective in any such machine except that the temperature difference at the spindle in the up-feed machine may cause considerable condensation under high-humidity atmospheric conditions. In other words, milk at a temperature of around 40 degrees Fahr. is passing upward through the hollow spindle the outside surface of which is exposed to oil spray at a temperature often well above 100 degrees Fahr. High humidity air in the gear case will therefore be subjected to considerable condensation. Routine drawing off of water from the gear-case is therefore customary to prevent development of emulsions by circulating water and oil.

A further precaution is to select only high quality oil of light to medium viscosity turbine grade which is specially refined to separate readily from water, resist emulsification and oxidation. It is important to remember that an unsuitable oil, violently agitated in the presence of water and air at elevated temperatures, may oxidize so readily as to develop serious accumulations of sludge. As sludge and oxidized petroleum oils show an acid reaction, the possibility of corrosion of ball bearing elements or the worm and gear is increased.

CONCLUSION

The importance of the dairy industry as an adjunct to health and maximum effort is self-evident. Milk, our most important food in either liquid, concentrated or powdered form, furnishes the balance of calcium so necessary if one is to function at his best. However, milk is a perishable product, highly susceptible to bacteria accumulation if exposed to contaminants, oxidation, over-heating or standing. So, the handling of milk must be expedited. From the farm to the consumer, machinery, therefore, is important. This has led to a remarkable synchronism of pumps, separators, motors, conveyors, chillers, pasteurizers and bottling equipment. Lubrication protects this equipment, keeps it running, reduces maintenance costs.

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POWER DRIVES

ELECTRIC MOTORS	
Bearings, Oil Lubricated	Texaco Canopus Oils
Grease Lubricated	Texaco Starfak Grease No. 2
Built-in Gears	Texaco Algol or Ursa Oil
GEARS — BEVEL OR WORM TYPE	
Bevel Gears, Enclosed	Texaco 650T Cylinder Oil, or Texaco Thubans
Exposed	Texaco 919 Lubricant S
Worm Gears	Texaco 650T Cylinder Oil
CHAINS	
Silent Chain Drives	Texaco Algol Oil
Exposed Chains	Texaco Thubans

PUMPS

CENTRIFUGAL OR ROTARY TYPE	
Oil Lubricated	Texaco Alcaid or Algol Oil
Grease Lubricated	Texaco Starfak Grease No. 2

CONVEYORS

PLAIN BEARINGS	
Oil Lubricated	Texaco Alcaid or Algol Oil
Grease Lubricated	Texaco Star Grease No. 1 or No. 3
BALL OR ROLLER BEARINGS	Texaco Starfak Grease No. 2

CREAM SEPARATORS AND CLARIFIERS

HAND SEPARATORS	Texaco Capella Oil AA
POWER-DRIVEN MACHINES	Texaco Capella Oil D or E

PASTEURIZING, WASHING, AND BOTTLING

BEARINGS	
Sleeve Type, Oil Lubricated	Texaco Alcaid or Algol Oil
Grease Lubricated	Texaco Star Grease No. 1 or No. 3
Ball or Roller Type	Texaco Starfak Grease No. 2
DRIVING OR REDUCTION GEARS	
Enclosed	Texaco 650T Cylinder Oil
Exposed	Texaco 919 Lubricant S
CHAINS	Texaco Algol Oil or Texaco Thubans

AIR COMPRESSORS

RECIPROCATING UNITS	Texaco Capella Oils
ROTARY MACHINES	Texaco Ursa Oils

REFRIGERATING MACHINERY

Texaco Capella Oils, according to type of compressor and refrigerant involved. See Texaco Capella Oil leaflet.

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